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GB 2264666 A GB 2075407 A

(58) Field of Search
UK CL (Edition M) B4B B29A B51X
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(54) Sheet cutting apparatus

(57) A sheet cutting apparatus comprises a cutting head 20 moveable in two directions, X - X, Y - Y, over a table 11 to cut shapes 15A from a piece of sheet material 15 by a pre-programmed controller. The cutting head carries cutting means consisting of a cutting blade 31 inclined at an angle to the vertical whereby to cut bevelled edges. The cutting angle of the cutting means can be altered by rotation of the cutting head about the vertical axis. There is also provision, 35 - 40, for moving the cutting means up and down relative to the cutting head in the plane of the cutting blade. Three movements, a rotational movement of the head, by means of motor 45 through gear 50, an up and down movement of the head, by means of actuator 41 acting on holder 43 in a rod 42, and a movement of a cutting blade relative to the head are all provided for so that complex shapes can be cut using pre-programmed control arrangement.

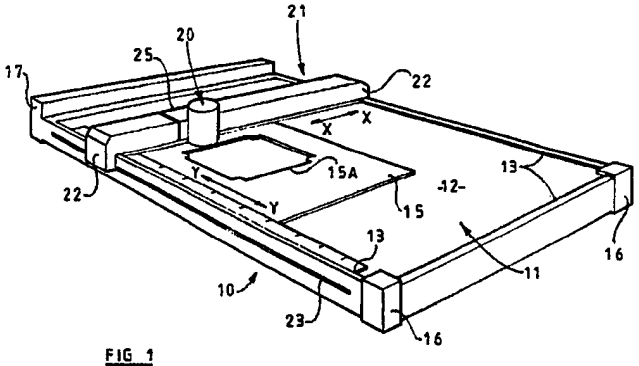

FIG 1

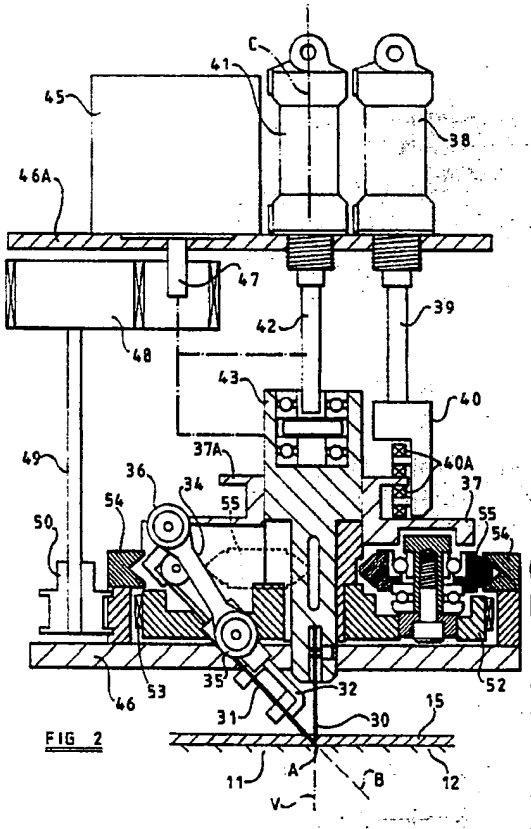

FIG 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

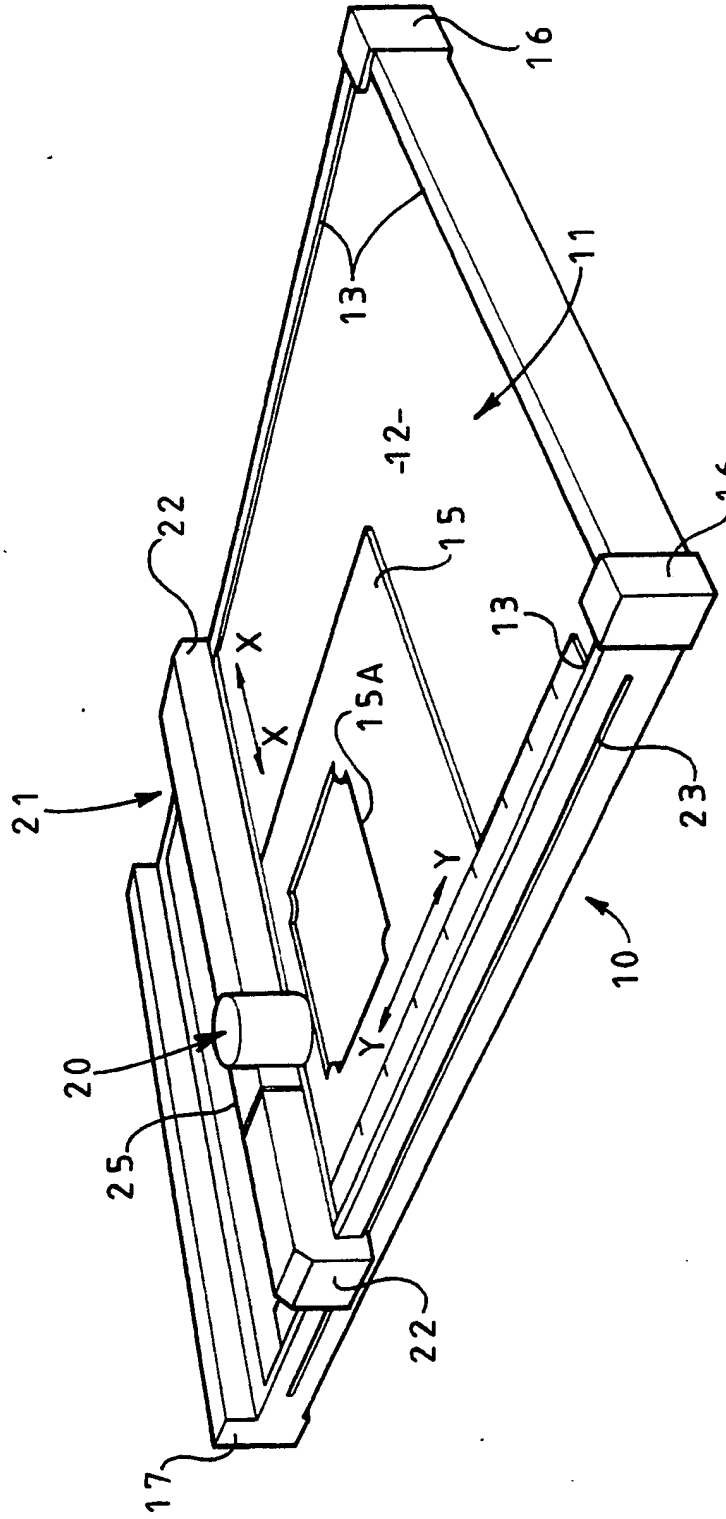

FIG 1

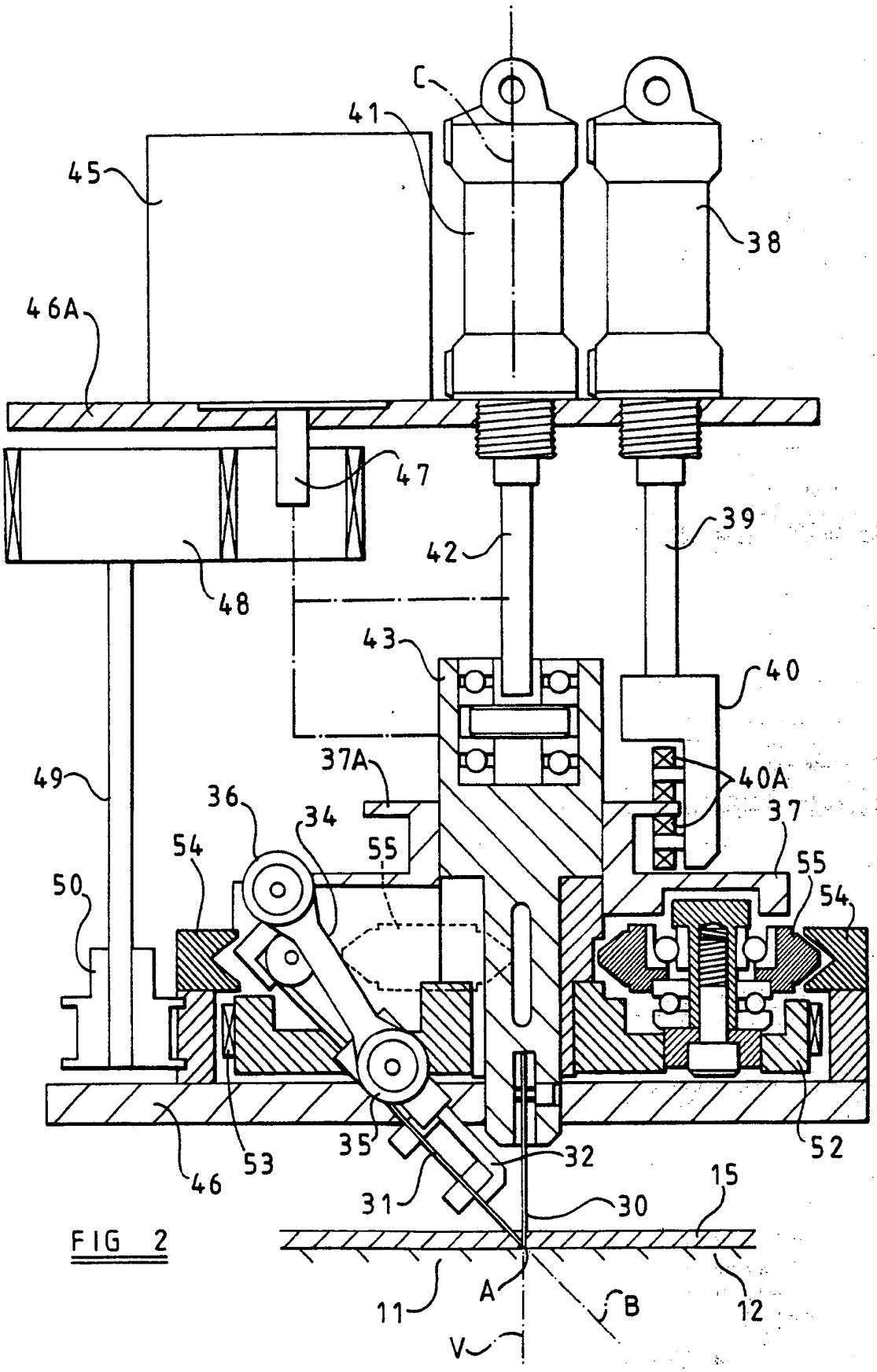
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FIG 2

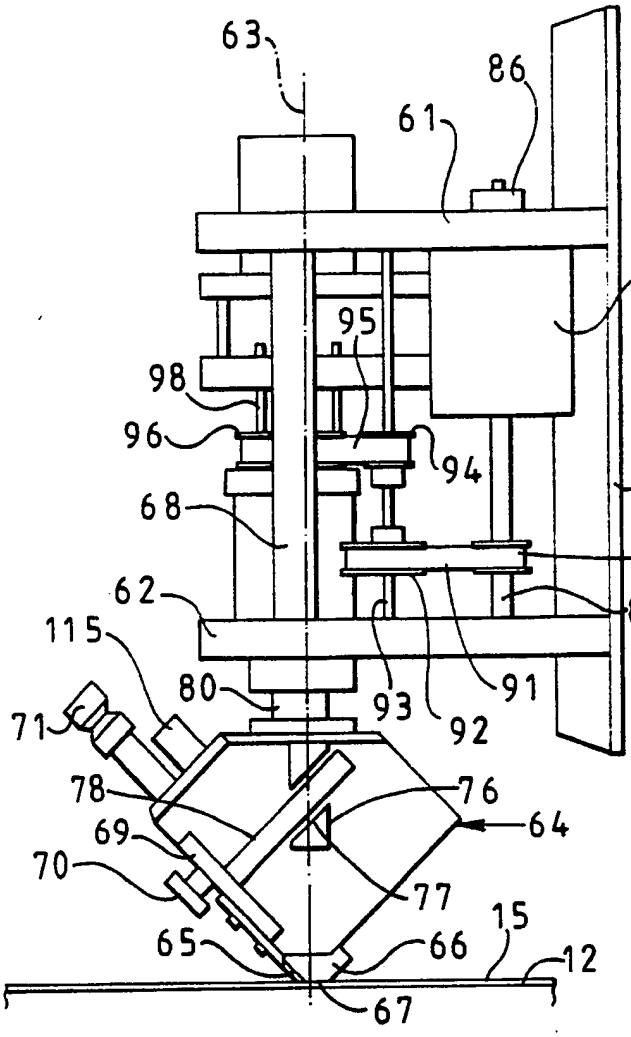

FIG 3

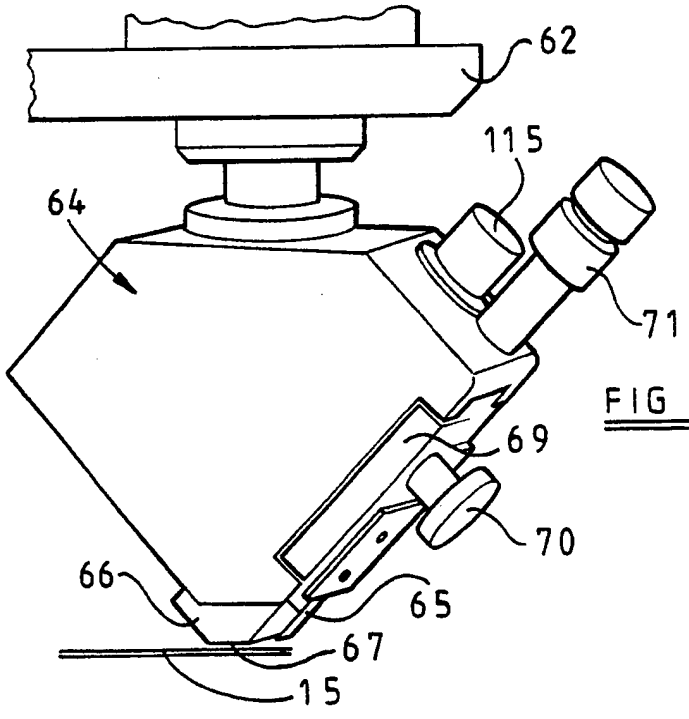

FIG 4

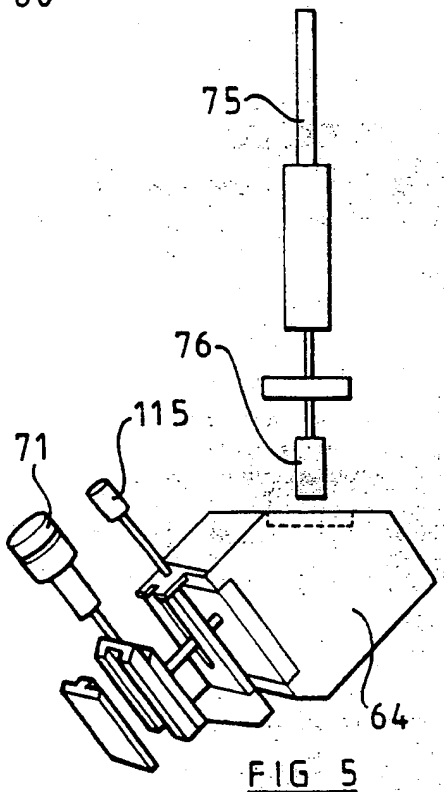

FIG 5

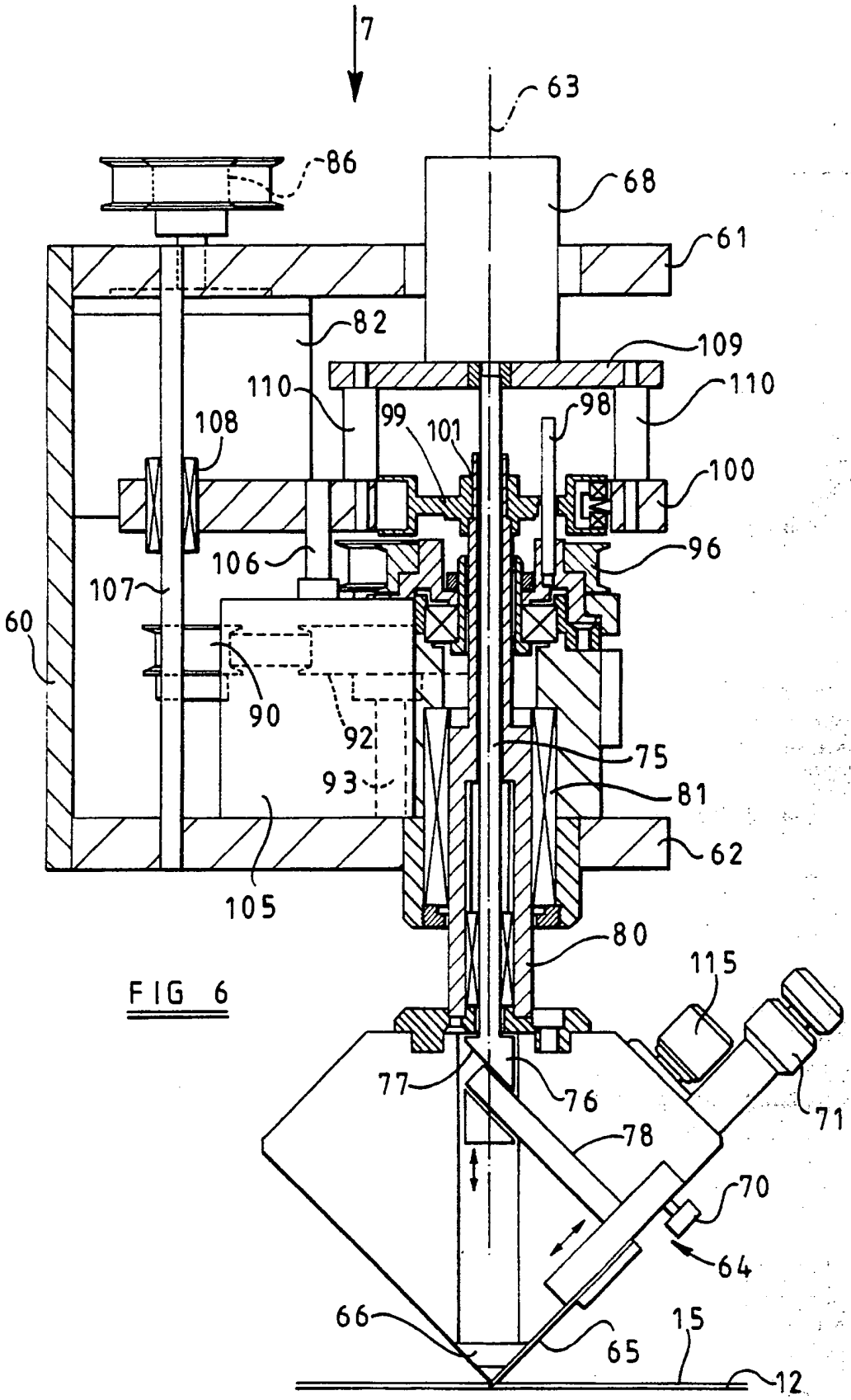
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FIG 6

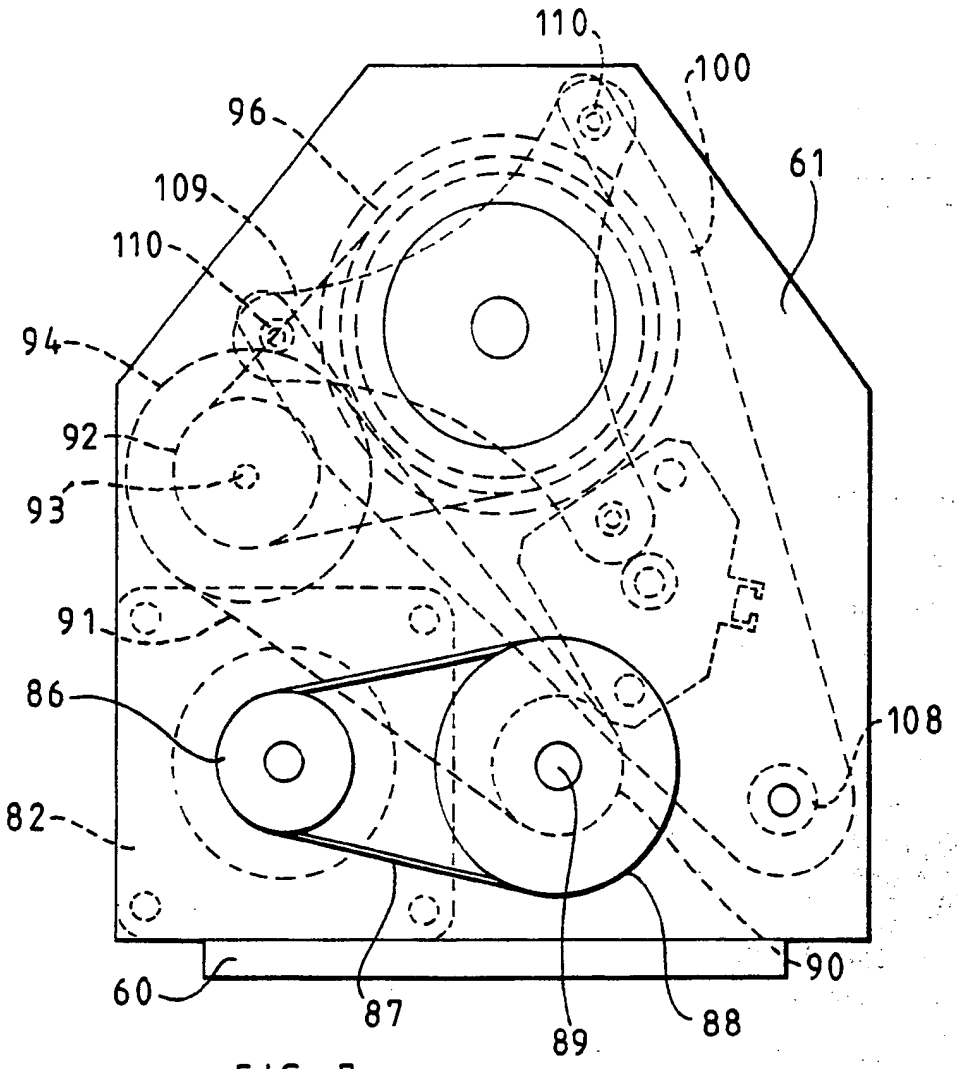

FIG 7

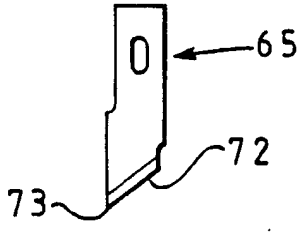

FIG 8

CUTTING APPARATUS

This invention relates to cutting apparatus and in particular to apparatus for cutting sheet material, for example, sheet material in the form of card along cutting lines which may be rectilinear, curvilinear or other more complex shapes and which are generally formed as cut out openings within the sheet or external peripheral shapes or both. Furthermore the sheet may be cut at an acute angle to the plane of the sheet.

In the cutting of sheet material to form mounts for picture framing there is a requirement for an opening to be formed in a generally rectangular sheet to be fitted into a frame. The opening may be of rectangular, circular, elliptical or other more complex shapes, depending on the picture or other item to be framed. Moreover, in some cases, the sheet is formed with a surface finish of contrasting colour so that when a cut is made at, say, 45° to the plane of the sheet, two differently-coloured portions are presented and visible at the edge of the opening, in the form of a bevel.

Hitherto frame mounts have been cut by laborious manual methods assisted by cutting equipment which has to be manually set and operated. Such manual methods have been found to be particularly difficult to employ when inclined or bevelled cuts are called for.

An object of the invention is to provide cutting apparatus which is capable of cutting sheet material with a minimum of manual involvement.

According to the invention cutting apparatus comprises a cutting table on which sheet material to be cut is laid, a cutting head movable over the table, cutting means carried by the cutting head for effecting cutting of the sheet material, support and drive means for the cutting head whereby the

cutting head is positioned and moved over the plane of the cutting table during a cutting operation, mounting means for movably mounting the cutting means on the cutting head whereby the cutting means is movable towards and away from the cutting table and into and out of a cutting position, rotation means on the cutting head whereby the cutting means is rotatable about an axis at a right angle to the plane of the cutting table axis to align the cutting means with the cutting direction, and control means for controlling the movement of the cutting head relative to the cutting table and of the cutting means in relation to the cutting head according to the cutting action to be performed, the cutting means including at least one cutting blade having a cutting edge and the plane of the cutting edge lying at an acute angle to the plane of the sheet to be cut by said edge, the cutting blade being movable reciprocally in said mounting means in a direction parallel to the plane of said edge.

Preferably the cutting blade has a tip which, in the operative cutting position, lies on the axis of rotation of the cutting head and at the surface of the cutting table.

Conveniently the cutting head is reciprocally movable in a direction at a right angle in relation to the plane of the cutting table, and in the operative position of the cutting head the lower end of the head is urged into engagement with the sheet to be cut.

The axis of rotation of the cutting head, the line of reciprocal movement of the head, and the axis of drive means for moving the cutting element relative to the head may be coincident and directed through the cutting head.

The cutting head may include a shaft drivingly connected to drive means for rotating the shaft, and coaxially located within the shaft is a spindle axially reciprocal relative to the shaft and supporting the cutting blade for movement

relative to the shaft to move the cutting blade between operative and inoperative positions under the action of drive means for effecting the reciprocal movement of the cutting blade.

The cutting blade may be releasably mounted on a slide movable in the direction of the plane of the cutting edge, the slide being drivingly connected to drive means for moving the slide reciprocally in said direction.

Conveniently the slide and the drive means are relatively slidably located and connected through interengaging sliding members.

Further features of the invention will appear from the following description of two embodiments of the invention given by way of example only and with reference to the drawings, in which:-

Fig. 1 is a perspective view of cutting apparatus according to one embodiment of the invention,

Fig. 2 is a vertical section through a cutting head of the apparatus of Fig. 1,

Fig. 3 is a side view of a second embodiment of the invention,

Fig. 4 is a perspective view of the cutting head of the Fig. 3 embodiment,

Fig. 5 is a side view showing part of the drive arrangement to the cutting head of Fig. 4,

Fig. 6 is a sectional vertical elevation of the embodiment of Figs. 3-5,

Fig. 7 is a plan view in the direction of arrow 7 in Fig. 6, and

Fig. 8 is a plan view of a cutting blade.

Referring to Figs. 1 and 2 of the drawings there is shown cutting apparatus primarily intended for cutting sheet material, such as material to be made into mounts for picture framing.

The apparatus comprises a generally rectangular base 10 defining a rectangular cutting table 11 having a sheet receiving cutting surface 12 bounded along its edges by upstanding edges 13 against which sheets 15 of paper or card to be cut are located. Although shown horizontal the base 10 may be vertical or inclined to the vertical.

The base 10 has corner posts 16 at one end for supporting the base 10 and at the other end the base 10 carries a housing 17 for controls and drive means (not shown) for a cutting head 20.

The cutting head 20 is mounted movable on a beam 21 so that the head is movable longitudinally of the beam 21 in a direction X-X and the beam 21 is mounted on the base 10 for movement in a direction Y-Y at a right angle to the beam 21 and parallel to the longer sides of the base, the head moving parallel to the other, shorter sides of the base.

Drive means (not shown) for the beam 21 is attached to opposite ends of the beam and is located in the base, driving connection between the beam and the drive means being made between arms 22 at the outer ends of the beam which locate in slots 23 extending along opposite sides of the base. The beam 21 is mounted on the base to be supported thereby by slideways or rollers (not shown) between the beam and the base.

The cutting head 20 is movably mounted on the beam 21 by a mounting member 25 which is drivingly connected to drive means (not shown) which moves the mounting member 25 along the beam. The mounting member 25 is supported by the beam for movement therealong by suitable bearings (not shown).

By the general arrangement of the base 10, the beam 21 and the head 20 and the associated drive means, the head 20 can be moved by a combination of movements in the directions X-X and Y-Y to any position on the surface 12 to effect a cutting operation on the sheet 15 on the surface 12.

Such movement is caused by motors of the drive means and is controlled by suitable control means. Conveniently the movement of the head 20 is controlled electronically by computer-generated signals pre-programmed into the computer. Thus the head can be programmed to follow a series of movements to give any desired shape to be cut into the sheet material 15 such as the generally rectangular shape 15A shown in which the corners of the rectangle are arcuate. Any other shapes can be programmed into the control system such as rectangles, circles, ellipses or more complex shapes according to the program. Moreover the shape or different shapes can be repeated over the area of the sheet 15 to obtain multiple cut-outs.

If desired the sheet may be cut to the outline required for individual mounts or the sheet may be removed for cutting the outline since this is usually a cutting operation easily performed by a guillotine, the shapes generally being along straight lines. Alternatively the sheet may be cut to give a sheet portion with a predetermined external periphery and no cut out portion.

Turning now particularly to Fig. 2 there is shown the cutting head 20 which in this case is provided with two cutting elements 30 and 31 each in the form of cutting knives

removably mounted on the head 20. One of the cutting elements 30 is vertically mounted, that is with the plane of the knife extending vertically and the cutting edge lying in the vertical plane V.

The other of the elements 31 is mounted so that it lies with its plane B at 45° to the vertical and with its cutting edge lying in this plane, and the element 31 is for cutting edges in the sheet 15 which lie at 45° i.e. bevelled edges. It will be seen that the planes V and B intersect one another at a position A which lies closely adjacent the surface 12 on which the sheet 15 lies.

In practice, although both knives 30 and 31 are shown in the operative position in Fig. 2, only one of the knives will be operative at any one time, the other knife being retracted to the inoperative position, as will be described.

The knife 31 is releasably carried on a holder 32 and the holder is movable in a direction parallel to the plane B between the operative position, as shown, and an inoperative, non-cutting position in which the knife is clear of any sheet material 15 on the surface 12.

The holder 32 is mounted for slidable movement in the direction B by means of a link 34 pivotally mounted at one end 35 to the holder 32 and at the other end 36 to a vertically movable slide member 37. The member 37 is in turn coupled to a pneumatically-operated cylinder 38 fixedly mounted on the head 20 and having a reciprocally movable piston rod 39 to which a coupling member 40 is attached. Connection between the rotationally fixed member 40 and the member 37, which is rotatable about axis C, is through a pair of rollers 40A attached to the member 40 and engaging a disc portion 37A of the member 37.

The cutting head 20 is mounted about a vertical axis C which

is coincident with the position A and the axis C lies in the plane V.

A further pneumatically operated cylinder 41 is fixedly mounted on the head 20 and the cylinder lies along the axis C for operating the movement of the knife 30 between the operative position shown and an inoperative, non-cutting position which is raised above the level of any sheet material 15 lying on the surface 12. A piston rod 42 of the cylinder 41 is reciprocally movable upon operation of the cylinder 41 and is coupled to transmit this movement to a holder 43 for the knife 30. The holder 43 is rotatable relative to the rod 42.

The holders 32 and 43 hold the knives 30 and 31 to prevent unwanted movement of the knives in the direction transverse to their planes, relative to the holders.

The cutting head 20 carries a stepping motor 45 by which part of the head carrying the knives 30 and 31 is rotatable about the axis C relative to frame portions 46 of the head 20. The motor 45 is drivingly connected through a transmission system including a motor output shaft 47, a gearbox 48, a shaft 49 and a pinion 50.

The pinion 50 drives a toothed belt (not shown) which engages a rotatable toothed ring 52 having teeth 53 about its external periphery. The ring 52 carries three rotatable carrying members 55 equally spaced about the axis C, the carrying members 55 each being adjustably mounted to engage with the radially inner surface of a fixed ring 54.

The carrying members 55 are rotatable about their respective axes and are each mounted on the rotatable ring 52 and serve to support the rotatable parts of the head relative to the fixed frame which includes the fixed ring 54, a lower frame member 46 and an upper frame member 46A.

Mounted on the rotatable parts of the head are the knife holders 32 and 43 and the means 37 for moving the knife holder 32 between the operative and inoperative positions.

In operation the motor 45 is controlled by the apparatus control means to rotate the rotatable part of the head 20 so that the operative knife 30 or 31 always lies with its plane V or B tangential to the direction of travel of the knife. Thus the control means detects the direction of travel and orients the knife by operation of the motor 45 according to the direction of travel by rotation about the axis C. Hence it is important that the point A lies coincident with the axis C.

Referring now to Figs. 3-8 there is shown apparatus comprising a cutting head of different form to that shown in Figs. 1 and 2 but which is to be used in the apparatus of Figs. 1 and 2 in substitution for the cutting head 20 described in relation to that embodiment.

The cutting head of Figs. 3-8 includes a mounting plate 60 by which the head is mounted movably along the beam 21 of Figs. 1 and 2 and the mounting plate 60 carries a pair of vertically spaced supports 61 and 62 interconnected by vertical pillars 63 to provide a rigid frame for the cutting head.

Projecting downwards from the lower support 62 and rotatable about a vertical axis 63 is a fixture 64 on which a cutting blade 65 (Fig. 8) is carried, the blade 65 lying in a plane at 45° to the horizontal and to the sheet 15 to be cut which lies on the surface 12.

The fixture 64 is formed as a generally triangular block having at its lower end a bearing member 66 with a bearing surface 67 which is arranged to be urged against the upper surface of the sheet 15 of the material to be cut. The block tapers upwards and outwards from the member 66 at an angle of

45° to the horizontal and the knife or blade 65 is releasably attached along a side edge of the block 64 to be movable towards and away from a cutting position in which the lower tip of the blade lies on the axis 63 when in the cutting position. Such movement is in the plane of the blade 65 and is generated by a pneumatic cylinder through a drive arrangement, as will be described.

The blade 65 is held in position against a surface at said 45° angle and is carried on locating means 69 which is removable by operating a screw threaded knob 70 in order that the blade 65 may be replaced when worn.

The locating means 69 is carried slidably movable on the block 64 for manual adjustment of the blade 65 relative to the block 64 using an adjustment device 71 by which the blade 65 and its locating means 69 are movable in the plane of the blade to ensure that the blade takes up the desired cutting position in use.

The blade is of the form shown in Fig. 8 having a generally flat shape with a chamfered cutting edge 72 which is inclined at an acute angle to the longitudinal direction of the blade and terminates in a point 73 which, as previously mentioned, lies on the axis 63 and, in use, is located at the level of the surface 12 by operation of the device 71. The chamfered surface of the blade is directed downwards and the blade is urged against its supporting surface during use.

The locating means 69 carrying the blade 65 is also movable in and out of an operative position by movement in the plane of the blade 65 by use of the cylinder 68, such movement being made when the cutting direction of the cutting head and hence of the cutting blade needs to be changed, for example, when cutting a right-angle corner in the sheet 15. Operation of the pneumatic cylinder 68 which is operatively connected to a central operating rod 75 causes reciprocal movement of the rod

in its axial direction to move the locating means 69 and hence the blade 65. At its lower end the rod 75 extends into the block 64 and carries a bearing member 76 which is apertured in a direction oblique to its axis at 77 to receive a slide member 78 which is in turn connected to the locating means 69 for the blade 65. As the rod 75 is moved up and down the locating means, through the bearing member 76 and the slide member 78, moves along the inclined surface of the block 64 and the blade 65 is moved in and out of an operative position.

The rod 75 is located within a tubular shaft 80 having its longitudinal axis at the axis 63 and at its lower end the shaft 80 is secured to the block 64 for rotation therewith.

The shaft 80 is located and supported in bearings 81 on the support 62 and is drivingly connected to a stepping motor 82 carried on the support 61. Drive between the shaft 80 and the motor 82 is through a series of belts and pulleys.

An output shaft of the motor 82 carries a pulley 86 and a belt 87 drivingly connects the pulley 86 to a pulley 88 carried on a first lay shaft 89. The shaft 89 carries a further pulley 90, and a belt 91 connects the pulley 90 to a further pulley 92 mounted on a further lay shaft 93 which drives a pulley 94.

The pulley 94 drives a further pulley 96 through a belt drive arrangement and the pulley 96 is located coaxially of the shaft 80 so that the shaft 80 is axially movable relative to the pulley 96 but is drivingly connected to the shaft 80 by three pins 98 located at 120° about the shaft and the pins 98 being rotatable with but slidably engagable with a ring member 99 mounted for rotation relative to a gimbal arm 100.

The ring member 99 is drivingly connected through longitudinal spines 101 to the upper end of the shaft 80 and carries cooperating teeth so that the ring member 99 maintains driving connection with the shaft 80 whilst being movable relative to

the shaft in the axial direction during vertical movement of the gimbal arm 100, as will be described.

The pulleys in the drive from the motor 82 to the ring 99 give a reduction ratio of, say, 10:1 and the stepping motor 82 is able to rotate the shaft 80 in very small increments to orientate the cutting head 20 and the cutting blade 65 in the desired cutting direction and as programmed by the control means of the apparatus.

The shaft 80 is carried on the lowest support 62 in the bearings 81 for movement about its axis and also for linear movement along its axis whereby the block 64 is movable up and down towards a cutting position in which the bearing surface 67 of the member 66 is urged into engagement with a sheet 15 to be cut, and an inoperative position in which the member 66 and hence the cutting blade 65 is spaced upwards from the sheet 15.

The axial movement of the shaft is generated by a pneumatic cylinder 105 mounted on the lower support 62 and arranged to move a piston rod 106 in the vertical direction. The rod 106 is connected to the gimbal arm 100 which is supported for vertical movement relative to support rods 107 on bearings 108. The gimbal arm 100 carries a gimbal plate 109 above the arm 100 on gimbal spacers 110 and the pneumatic cylinder 68 for moving the rod 75 is mounted on the gimbal plate 109 for movement therewith. Hence the adjustment of the cutter blade position relative to the block 64 is effected irrespective of the position of the block 64 in relation to the surface 12.

To position the block 64 relative to the surface 12 the cylinder 105 is operated to drive the piston rod 106 in the selected direction to move the block 64 up or down. The movement of the rod 106 is transmitted to the gimbal arm 100 and associated gimbal plate 109 and the gimbal arm 100 is connected to the upper end of the shaft 80 to move the shaft

up and down and move the block 64 up and down relative to the surface 12. During movement of the gimbal arm 100 up and down the rotational drive to the shaft 80 is maintained by the keying of the ring member 99 to the shaft 80 and the relative sliding movement between the pulley 96 and the ring member 99. By this means the block 64 is urged towards the sheet 15 to be cut.

To provide a more cushioned movement of the shaft 80 up and down there may be provided between the gimbal arm 100 and the lower support 62 spring means. Similarly spring means may be provided to cushion the upward movement of the shaft 80.

In operation the position of the cutting head on the table 12 is continually adjusted by the control means according to the desired shape of cut. The cutting blade position can also be changed during cutting, by rotation of the shaft about the axis 63 or the position of the cutting blade can be changed intermittently. During a continuous change of the cutting direction, i.e. during the cutting of a curve, the blade 65 is kept in cutting contact with the sheet 15 whilst the motor 82 rotates the block 64 about its axis 63 and control of the cutting direction of the blade 65 is determined by the control means which may be computer operated control means. In some cases the cutting direction is changed abruptly, for example to cut a corner, in which case the blade 65 may be moved upwards relative to the block 64 by operation of the rod 75. This permits the block 64 to be rotated about its axis 63 with the blade 65 retracted and upon a resumption of a cutting action the blade 65 is moved downwards into a cutting position by operation of the cylinder 68 to move the rod 75 downwards, the bearing surface 67 remaining in contact with the sheet 15.

It will be appreciated that sensors may be provided to sense the position of the blade 65 or of the rod 75 to determine that the blade is in its operative or inoperative positions.

If required the position of bearing member 66 in relation to the block 64 can be adjusted by operation of an adjustment member 115.

Although there is described and shown cutting elements in the form of knives or blades other cutting means may be used especially when cutting materials other than card are used. Moreover the apparatus may be used for other cutting operations to those described. For example metal or plastics sheet material may also be cut with the apparatus using suitable cutting means.

CLAIMS

1. Sheet cutting apparatus comprising a cutting table on which sheet material to be cut is laid, a cutting head movable over the table, cutting means carried by the cutting head for effecting cutting of the sheet material, support and drive means for the cutting head whereby the cutting head is positioned and moved over the plane of the cutting table during a cutting action, mounting means for movably mounting the cutting means on the cutting head whereby the cutting means is movable reciprocally relative to the cutting table and into and out of a cutting position, rotation means on the cutting head whereby the cutting means is rotatable about an axis at a right-angle to the plane of the cutting table to align the cutting means with the cutting direction, and control means for controlling the movement of the cutting head relative to the cutting table and of the cutting means in relation to the cutting head according to the cutting action to be performed, the cutting means including at least one cutting blade having a cutting edge and the plane of the cutting edge lying at an acute angle to the plane of the sheet to be cut by said edge, the cutting blade being movable reciprocally in said mounting means in a direction parallel to the plane of said edge.

2. Apparatus according to claim wherein the cutting blade has a tip which, in the operative cutting position, lies on the axis of rotation of the cutting head and at the surface of the cutting table.

3. Apparatus according to claim 1 or 2 wherein the cutting means is reciprocally movable in a direction at a right-angle in relation to the plane of the cutting table and in the operative position of the cutting means the lower end of said means is urged into engagement with the sheet to be cut.

4. Apparatus according to any one of the preceding claims

wherein the axis of rotation of the cutting head, the line of reciprocal movement of the head and the axis of drive means for moving the cutting element relative to the head are coincident and directed through the cutting head.

5. Apparatus according to claim 4 wherein the cutting head includes a spindle coaxial with the axis of rotation of the head and connected to the cutting blade for moving the cutting blade between an operative and inoperative position, a tubular shaft located around the spindle and rotatable around its axis to rotate the cutting means about said axis, the spindle being axially reciprocal relative to the tubular shaft and the cutting blade being reciprocally movable relative to the cutting means.

6. Apparatus according to any one of the preceding claims wherein the cutting blade is releasably mounted on a slide movable in the direction of the plane of the cutting edge, the slide being drivably connected to drive means for moving the slide reciprocally in said direction.

7. Apparatus according to claim 6 wherein the slide and the drive means are relatively slidably connected through interengaging sliding surfaces.

8. Sheet cutting apparatus substantially as described with reference to the drawings.

Relevant Technical Fields	Search Examiner
(i) UK Cl (Ed.M) B4B (B51X, B29A)	H F YOUNG
(ii) Int Cl (Ed.5) B26D (1/00, 01, 04; 3/00, 02)	Date of completion of Search 29 MARCH 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-8

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2264666 A (WESTON) see Figure 3	1
A	GB 2075407 A (GERBER) see Figures 1-4	1

Databases:The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).